

Remarks

Applicant respectfully request reconsideration of the present application in view of the foregoing amendments and the following remarks. Claims 1-20 are pending in the application. Claims 1, 2, and 3 are independent.

Claims Rejections 35 USC § 103

The Action rejects claims 1, 4, 8, and 10-12 under 35 U.S.C. 103(a) as being unpatentable over Sloan et al. ("Precomputed Radiance Transfer for Real-Time Rendering in Dynamic, Low-Frequency Lighting Environments") [hereafter "Sloan"] in view of Burke (US Patent 2003-0063096) [hereafter "Burke"]. The Action rejects claims 2, 3, 5, 12, 13, and 15-20 under 35 U.S.C. 103(a) as being unpatentable over Sloan et al., in view of Burke in further view of Morioka et al. (US Patent 6,333,742) [hereafter "Morioka"]. The Action rejects claim 9 under 35 U.S.C. 103(a) as being unpatentable over Sloan et al., in view of Burke in further view of Arvo et al. ("Monte Carlo Ray Tracing") [hereafter "Arvo"]. The Action rejects claim 14 under 35 U.S.C. 103(a) as being unpatentable over Sloan et al., in view of Burke in further view of Morioka et al. and in further view of Airey et al. (U.S. Patent 6,650,327) [hereafter "Airey"]. Applicants traverse the rejections.

To establish a prima facie case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. (MPEP § 2142.)

Motivations to combine or modify references must come from the references themselves or be within the body of knowledge in the art. (See, MPEP § 2143.01.)

Claim 1

Claim 1 recites iterating a loop of steps (i.e., "rendering the object from the direction...", "determining cosine terms...", "determining shadowing...", "determining radiance transfer

contribution...,” and “accumulating radiance transfer contributions...” for a set of directions, where steps inside the loop iterate over plural points. The claim more specifically recites,

- iteratively, for each of a set of directions sampled about the object,
 - rendering the object from the direction to produce a shadow buffer representing depth from the object in the direction for the set of points;
 - as a texture-based operation, determining cosine terms of the set of sampled points for the currently iterated direction based on the normals represented in the object normals texture and currently iterated direction;
 - as a texture-based operation, determining shadowing of the set of sampled points for the currently iterated direction based on the depths represented in the shadow buffer and positions represented in the object positions texture;
 - as a texture-based operation, determining radiance transfer contribution of the set of sampled points for the currently iterated direction based on the determined cosine terms and shadowing; and
 - accumulating the radiance transfer contributions of the set of sampled points for the currently iterated direction with that of previously iterated directions;

The cited art fails to teach or suggest performing this outer loop of steps iterating over plural directions, where the steps inside the loop iterate over plural points. The Office asserts this recited outer loop of steps iterating over directions, and inside steps iterating over points is described by Sloan. Applicants respectfully disagree.

Sloan describes a radiance transfer pre-computation at section 5, which operates as summarized in the present application at p. 7, lines 12-22 and illustrated in Figures 1-3 of the present application. This process has an outer loop that iterates over sample points, and iterates over directions as inner loop steps. As such, Sloan teaches directly away from the recited outer loop iterating over directions, and inside steps iterating over points.

At pages 5-6 of the action dated June 14, 2006, the Office asserts that because the specification of the present patent application at page 8 describes reversing the order of inner and outer loops, then it would be obvious to one of ordinary skill to do so. Such rationale is an exercise of improper hindsight reasoning. MPEP § 2143 states, “The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, not in applicant’s disclosure. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991) [emphasis added].” The discussion at page 8, line 22 through page 9, line 3 was not available to those of ordinary skill in the art at the time of the invention, and therefore certainly

could not have led such person to alter Sloan's radiance transfer pre-computation to arrive at the method recited in claim 1.

The Office (at page 6 of the action) further asserts the recited method would be obvious because "the loop would perform the same number of iterations and produce the same radiance transfer output." Again, the Office fails to cite any prior knowledge in the art that this would be so, or even cite (improperly) any discussion in the present application for support. In fact, the method as recited in claim 1 has 3 separate steps ("determining cosine terms...", "determining shadowing...", and "determining radiance transfer contribution...") which iterate over the points represented in the textures. Despite this seemingly greater number of iterations, the method can achieve more efficient computation on graphics hardware because these steps can be performed on such hardware as "texture-based operations." This is not known to be practicably feasible for the radiance transfer pre-computation as described at section 5 of Sloan.

The Office (at page 6 of the action) finally asserts, "it would be obvious to one of ordinary skill in the art to reverse the outer and inner loops because the loop would... produce the same radiance transfer result." However, the Office fails to provide any showing that merely exchanging the value iterated over in the outer and inner loops would produce the same result. For example, the prior art computation is shown in Figure 3 of the present application as follows:

```
For each point P
  Accum = 0
  For each direction D
    Hn = dot(D,N)
    if (Hn < 0) continue;
    if (RayDoesNotIntersect(P,D))
      Accum += B(D)*Hn
  End For
  T = Accum/Norm
End For
```

If we merely switch the values iterated by inner and outer loops of this process, the result would be:

```
For each direction D
  Accum = 0
  For each point P
    Hn = dot(D,N)
    if (Hn < 0) continue;
    if (RayDoesNotIntersect(P,D))
      Accum += B(D)*Hn
```

```
End For  
T = Accum/Norm  
End For
```

The result of the Figure 3 prior art computation yields a radiance transfer value at each of the points P which is the accumulated contribution over all directions for that point. By contrast, the result for the latter computation is a transfer value per direction that is the accumulated contribution from all points for that direction. The transfer per direction produced from the reversed calculation is not the same as the transfer per point of the prior art calculation. So, merely reversing what value is iterated in the outer and inner loops actually does not produce the same result.

Burke is cited by the Office for the proposition of storing normals for a set of points as a texture. However, there is no teaching or suggestion to apply such a normals texture to the radiance transfer pre-computation in Sloan. In fact, one of ordinary skill in the art would not be led to use the texture containing normals described in Burke with the radiance transfer pre-computation as described in Sloan, because Sloan's radiance transfer pre-computation which iterates over directions in the inner loop would have to read a single normal value out of the Burke's texture for the steps in the inner loop. This reading a single normal value per inner loop iteration would be a very inefficient operation on graphics hardware.

In short, the Office fails to cite to any knowledge (whether in the cited art or elsewhere) that was available to those of ordinary skill at the time of the invention that would have led to the recited method with outer loop of steps iterating over plural directions, where the steps inside the loop iterate over plural points.

For the reasons just discussed, the cited art fails to teach or suggest the method as recited in claim 1, and actually would have led those of ordinary skill in the art away from the claimed method. Claim 1 therefore should be allowable over this art.

Claim 2 and 3

Claims 2 and 3 also recite language concerning iterating a loop of steps for a set of directions, where steps inside the loop iterate over plural points. For example, claim 2 more specifically recites,

wherein the at least one pixel shader executing on the graphics processing unit performs texture operations that iteratively, for each of a set of directions sampled about the object,

render the object from the direction to produce a shadow buffer representing depth from the object in the direction for the set of points;

determine cosine terms of the set of sampled points for the currently iterated direction based on the normals represented in the object normals texture and currently iterated direction;

determine shadowing of the set of sampled points for the currently iterated direction based on the depths represented in the shadow buffer and positions represented in the object positions texture;

determine radiance transfer contribution of the set of sampled points for the currently iterated direction based on the determined cosine terms and shadowing; and

accumulate the radiance transfer contributions of the set of sampled points for the currently iterated direction with that of previously iterated directions [Emphasis added].

For the reasons discussed above for claim 1, Sloan and Burke fail to teach or suggest performing this outer loop of steps iterating over plural directions, where the steps inside the loop iterate over plural points, as in the recited language of claims 2 and 3.

Morioka also lacks any teaching or suggestion to process a radiance transfer coefficient computation using an outer loop iterating over directions, with inside steps iterating over points. The Office alleges Morioka “teaches the at least one pixel shader executing on a graphics processing unit performing texture operation form (sic) each direction sample about the object in column 12, lines 52-51...” However, Morioka describes the textures as corresponding to pixels, and the computation “computes colors for each pixel.” This description would not lead one of ordinary skill to devise a pixel shader for a “radiance transfer coefficient computation” having an outer loop iterating over directions, and inside steps iterating over points, as recited in these claims.

Claims 2 and 3 therefore also should be allowable over this art.

Claim 4-20

Dependent claims 4-20 each depend from one of claims 1-3, and therefore should be allowable over Sloan, Morioka and Burke for at least the reasons of their respective base claims. Arvo and Airey also lack any teaching or suggestion to alter the radiance transfer pre-computation of Sloan in any way that would consist of an outer loop iterating over directions,

where steps inside the loop iterate over points. For at least these reasons, the claims should be allowable over the cited art.

Request for Interview

If any issues remain in light of these remarks and amendments, the Examiner is formally requested to contact the undersigned attorney to arrange a telephonic interview. It is believed that a brief discussion of the merits of the present application may expedite prosecution. Applicants submit the preceding formal Amendment and the above remarks so that the Examiner may fully evaluate Applicants' position, thereby enabling the interview to be more focused.

This request is being submitted under MPEP § 713.01, which indicates that an interview may be arranged in advance by a written request.

Conclusion

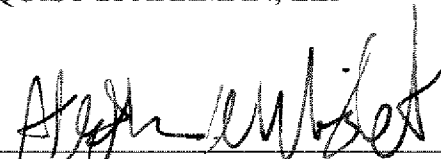
The claims in their present form should be allowable. Such action is respectfully requested.

Respectfully submitted,

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